

Betting the farm: A review of Ball Python and other reptile trade from Togo, West Africa

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Abstract

Our review of the CITES trade database confirmed that the ball python is the most exported species by Togo; with 1,657,814 live individuals – comprising 60% of all live reptiles – reported by importing countries since 1978 (almost 55,000 annually since 1992). In total, 99% of the ball pythons legally exported from Togo under CITES were intended for commercial use, presumably as exotic pets. Since the turn of the century, wild-sourced snakes exported from Togo have been largely replaced with ranched snakes, to the extent that in the last 10 years 95% of these live exports were recorded using CITES source code “R” with the majority destined for the USA. We found discrepancies in the CITES trade database that suggest ball python exports were consistently underestimated by Togo and that both ranched and wild-sourced ball python annual quotas have been exceeded on multiple occasions including as recently as 2017. Furthermore, our field visits to seven of these “python farms” revealed that they are also involved in the commercial trade in at least 46 other reptile species, including eight that are already involved in formal CITES trade reviews due to concerns regarding their sustainability and legality. Ranching operations in West Africa were once thought to provide a degree of protection for the ball python; however, in light of

recent research, there is growing concern that ranching may not confer any significant net conservation benefits. Further scrutiny and research are required to ensure the long-term survival of wild ball python and other reptile species populations in Togo.

Keywords

CITES, conservation, *Python regius*, ranching, wildlife trade

Introduction

The exotic pet trade is an enormous global enterprise (Bush et al. 2014) involving international trade in millions of individuals of thousands of species, only some of which are regulated [under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)] (Can et al. 2019). For some species, captive breeding in destination countries (e.g., the USA and some European countries) also takes place, however others are obtained directly from source countries, commonly from the subtropical and tropical region (e.g., Bush et al. 2014; Harrington 2015; Jensen et al. 2018), which, in some cases, can provide an important income source for local communities (e.g., D'Cruze et al. 2020a).

To assess the long-term sustainability of such trades, an understanding of trade patterns is crucial. With this remit, trade in ball pythons (*Python regius*) (a popular pet in many countries, particularly the USA), exported by Togo (one of the species' Range States, and one of the main source countries involved in international export), is an informative case study – in part because it illustrates an almost complete shift from wild-captured individuals to the use of ranching. Ranching (defined below) is a production system, intended as a potential solution to the unsustainable harvest of wild animals, dependent on “farms” that do not function as farms in the traditional agricultural sense, rather they are continually dependent on a wild source that is by definition “surplus” to the wild population [i.e. that portion of the population that would likely suffer naturally high mortality rates in the wild (CITES glossary 2019, <https://www.cites.org/eng/resources/terms/glossary.php>)]. This paper explores changing trade patterns (numbers, source, and markets) in ball pythons from Togo, carried out as part of a broader study of the relationships between in-situ and ex-situ harvesting with respect to sustainable wildlife use. Here we focus on the farms involved in ball python trade (the extent and changing nature of their trade, including the markets that they supply, and other reptiles collected for export), elsewhere we address ball python supply (D'Cruze et al. 2020a) and trade links with neighbouring Range States (Harrington et al. in prep.).

Togo is a relatively small West African country (56,790 km²) bordered by Ghana to the west, Benin to the east, Burkina Faso to the north and the Gulf of Guinea to the south. It comprises a long strip of land located between a latitude of 6°–11°N and a longitude of 0°–2°E, stretches over 660 km from north to south and has a coastline of 50 km, east-west (Segniagbeto and Van Waerebeek 2010). Its maximal width is 120 km between 7 and 8°N. The wet season is pronounced in the south with

two rainfall periods, between April and July, and September and November; the dry season is introduced by the Hamattan desert winds between November and March (Segniagbeto et al. 2011). The landscape is largely a gently undulating plain, with the exception of the Atakora range (“chaîne de l’Atakora”), which crosses the country in a northeast-southwest direction (Segniagbeto and Van Waerebeek 2010). As a consequence of its location, the Togolese landscape consists, from south to north, of a succession of various ecosystems ranging from coastal grasslands to equatorial and wet tropical forests, and ending in Sudan savannahs in the North that is traditionally divided into five distinct ecological zones (Ern 1979; Novinyo et al. 2015). The diversity in these ecosystems is considered as being highly favourable to herpetofaunal diversity, especially snake species of which the majority are confined to specific biotopes (Segniagbeto et al. 2011).

Research focused on reptile diversity in Togo date back to the time of German colonisation and herpetologists such as Sternfeld who published the first inventory of Togolese snakes that included a total of 75 species (Sternfeld 1908). Further research followed in subsequent decades [e.g., Loveridge 1939, 1944, 1958; Hulselmans et al. 1970; Roman 1984; and Anonymous 2002 (a monograph of the national survey of the biological diversity in Togo)]. In 2011, Segniagbeto et al. produced an annotated list of 91 snake species currently recorded from Togo. Although these authors recognised that some taxonomic uncertainties require further scrutiny this remains the most recent review of snake diversity in Togo carried out to date. With regards to their conservation status, 30 (33%) of these snake species, representing 12 different families, have been assessed according to the IUCN Red List of Threatened Species (IUCN 2019). This resulted in 29 species being classified as Least Concern and one species, the lined centipede-eater (*Aparallactus lineatus*) being classified as Near Threatened (IUCN 2019). With regards to their population status, seven of these 30 species have populations considered to be stable and the remaining 23 species have populations of unknown status (IUCN 2019).

Togo is recognised to be one of the main reptile exporters of sub-Saharan western Africa with several species currently harvested at significant levels for the international “exotic” pet trade (Affre et al. 2005; Jensen et al. 2018). In particular the ball python (*Python regius*), a species endemic to parts of Central and West Africa, is being exported in relatively large numbers, in fact it is the single most traded CITES listed live animal legally exported from Africa (Auliya et al. 2020; D’Cruze et al. 2020a). To date, the ball python has been subject to some biological and ecological studies focused on specimens in the wild [e.g., dietary preferences (Luiselli and Angelici 1998), and ectoparasite comparisons (Luiselli 2006) between sexes]. However, these studies notwithstanding, currently there remains a near complete lack of information on ball python home range sizes and activity patterns (in terms of both sex, age class, and season) throughout its range. This lack of information impedes the effective management of commercial trade and the assessment of its (and other anthropogenic-induced) impacts on wild ball python populations (cf. Auliya et al. 2020).

Much of the international ball python trade can be traced back to a number of registered reptile “farms” that are in operation across West Africa, most notably Benin,

Ghana and Togo (Robinson et al. 2015). Although some of these farms initially became involved with the international commercial trade of ball pythons in the 1960s (de Buffrénil 1995; Ineich 2006), since 1997, these farms have also officially been engaged in “ranching” (UNEP 2019) which refers to rearing, in a controlled environment, snakes taken as eggs or juveniles from the wild that would “otherwise have had a low probability of surviving to adulthood” (CITES glossary 2019), and releasing a proportion back into the wild (Ineich 2006). Additionally, wild gravid females are also collected, and after laying their eggs in captivity are released back into the wild (Ineich 2006; Luiselli et al. 2007). However, local hunters also collect wild ball python specimens (source code “W”) including adult males that are not released (D'Cruze et al. 2020a). In addition to commercially lucrative ball python, several other CITES and non-CITES listed reptile species are also collected for direct export (Ineich 2006). A number of missions have been carried out to assess ball python production methods at these farms (e.g., de Buffrénil 1995; Jenkins 1998; Affo 2001; Harwood 2003) including the most recent by Ineich (2006), who concluded that the practice of ranching being carried out by seven different farms in Togo was being done in “relatively healthy conditions”.

In terms of international trade regulation, the family Boidae (including all species taxonomically assigned to the Pythonidae) has been listed on the Appendices of CITES since 1977 (except *Boa constrictor* that was listed in 1975). Togo joined CITES in 1978, and entered into force in 1979 (CITES 2019), and since that time ball python exports have operated under a CITES Appendix II listing. Between 1992 and 2006 there were a number of CITES interventions to ball python trade in Togo. In 1992, the first two commercial reptile farms were reported for Togo (de Buffrénil 1995), and a CITES review of significant trade took place when Togo failed to provide relevant information as previously requested by the CITES Secretariat (Ineich 2006). Subsequently, the CITES Standing Committee recommended a temporary suspension of imports from this country (see Ineich 2006). Between 1993 and 1995 a suspension request was submitted, confirmed and ultimately cancelled while Togo implemented the recommendations from the CITES Animals Committee to better control exports (see Resolution Conf. 2.12). The management authority of Togo accepted the implementations in 1995 on the grounds that specimens should be described as “ranché”, not “captive-bred”, following an extensive review of practices on reptile farms in the country. CITES quotas were first introduced for wild-taken and ranché ball python specimens exported from Togo in 1990 (Affo 2001), with annual quotas set at 1,500 individuals for wild-sourced snakes, and ranging between 40,000 and 62,500 individuals for ranché snakes since then until 2019 (UNEP 2019). In 1997, the European Union (EU) listed the ball python on Annex B of Council Regulation No 338/97 (EU no 2017/160) which generally equates to CITES Appendix II. In 2015, the EU provided a positive opinion for importing ball pythons exported by Togo that were sourced from the wild, ranché or born in captivity (codes W, R and F respectively) (SRG 73 Soc).

Despite the relatively long-standing history of ball python ranching in Togo and recent / on-going endorsement from major importers such as the EU, the last detailed

examination of ball python production systems in West Africa was carried out almost 15 years ago (Ineich 2006). To help provide a more recent update, herein, we present detailed data on the ranching activities of farms currently involved in the ranching and export of ball pythons in Togo. The aim of our study was to:

- (1) Assess the extent and characteristics (source, purpose and destination) of ball python trade originating from Togo.

- (2) Quantify changes over time in the Togolese ball python trade, specifically with respect to the role of ranching and conformity with national annual trade quotas.

- (3) Provide a preliminary assessment of the wider activities of reptile farms in Togo with respect to the other species involved.

The overall objective of this study was to gain insights into potential impacts that this type of wildlife trade activity has on ball pythons and other reptiles in Togo. Ultimately, we hope our findings, and other recently published research focused on the reptile trade in Togo, will inform future interventions to aid conservation initiatives for this important site of herpetological biodiversity.

Methods

Desktop data collection

To determine the number of ball pythons exported from Togo, trade data were obtained from the CITES database. Countries exporting or importing species recognised by CITES are responsible for recording each trade transaction; a central database of all trade is publicly available at <https://trade.cites.org/>. To obtain numbers of ball pythons traded from Togo, all trade records pertaining to ball pythons exported from Togo, for all purposes, all source codes (outlined in Notification 2002/022) and all trade terms, were downloaded as a comparative tabulation from the CITES trade database. Further analysis of the trade data was limited to records of exports reported as “live” and for “Commercial” (T), “Breeding” (B), “Zoological” (Z) or “Personal” (P) use. All importing countries were included in the search criteria. Trade between the years 1978 (the year that Togo joined CITES) and 2018 were considered, and both exporter- and importer-reported quantities were used, and compared. Each “live animal” reported was presumed to represent an individual animal. The same data were obtained from the CITES trade database for all reptiles exported from Togo to enable assessment of the relative importance of ball pythons in the Togolese reptile trade.

Information detailing the annual trade quotas implemented by Togo (1997–2017) was obtained from the Species+ website (UNEP 2019). Quotas for both ranched and wild specimens were included. The quota data enabled a comparison with trade data obtained from the CITES database, to calculate to what extent Togo complies with trade restrictions for ball pythons.

For the USA specifically, the number of ball pythons imported from Togo between the years 2000 and 2017, was obtained from the U.S. Fish and Wildlife Service Law

Enforcement Management Information System (LEMIS) via a Freedom of Information Act (FOIA) request submitted to the Fish and Wildlife Service, Office of Law Enforcement which was received on 08.05.18 (control number FWS-2018-00788). This provided an independent source of trade data for one of the main importing countries for ball pythons, as well as additional information on individual Togolese exporters.

Field data collection

Research teams (composed of five different individuals) visited and collected data from eight different reptile farms across Togo during three field trips in 2018 (February, June and October) and two field trips in 2019 (February and April) lasting on average between 10 and 21 days. All official visits were organised under the guidance and permission of the CITES Scientific and Management Authorities in Togo. Photos of reptile species observed were taken with the consent of the farm owners; however, our aim was not to carry out a full inventory of the farm owner's stock. Rather, the images were taken to aid subsequent taxonomic identification. For all species, binomial nomenclature and information regarding their conservation, population status, and distribution was gathered from the IUCN Red List of Threatened species (hereafter the IUCN Red List, IUCN 2019). Conservation status was recorded in accordance with the 2001 IUCN Red List categories and criteria system (version 3.1) as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC) or Data Deficient (DD). Species Not Evaluated by the IUCN Red List (NE) were excluded from the analyses (please see Appendix I). Population status was recorded as Decreasing (D), Increasing (I), Stable (S), Not Evaluated (NE), and Unknown (U). Distribution was recorded for each species as Native (NA), RE (Regional), or W (Widespread) (please see Appendix I). To test whether the proportions of conservation or population status categories for these additional reptile species differed from expectation (relative to all reptile species recorded from Togo, i.e. whether farms were selecting particular categories of wild species), comparable data were collated for all reptile species in Togo from the IUCN Red List (IUCN 2019).

Statistical analysis

To test for trends over time in ball python exports from Togo, as recorded in CITES trade records, we summarised the records by year and used the *tslm* function in the “forecast” package (Hyndman 2017) in R to fit linear models to the resulting annual time series data, and to quantify and test the significance of trends. This analysis was carried out for all data (total exports) and regional-level data (where regional importers included Asia, Europe and North America [USA and Canada]). We used chi-squared tests to test for changes in the proportion of ranched and wild-sourced ball pythons among time periods and Pearson's correlation coefficient and t-tests to compare ex-

porter- and importer-reported numbers. For USA imports of ball pythons, we used t-tests to compare numbers imported as reported by CITES and LEMIS. Finally, we used chi-squared tests to compare proportions of conservation and population status categories among reptiles observed on farms with those present in the wild; note that this provides only a partial test for farm selection because many Togolese reptile species are not yet listed on the IUCN Red List and thus have no formally assigned conservation or population status. For chi-square tests, we obtained simulated p values (based on 2000 replicates) for tests with low expected values. Statistical analyses were carried out in R (version 3.5.1, R Core Team 2018).

Results

Ball Python and other reptile trade originating from Togo

The CITES trade database (<https://trade.cites.org>) contained 4,863 records of (live and dead) reptile exports from Togo between 1978 and 2017 (i.e. exports under all trade terms, including live animals, bodies and body parts), involving at least 51 species of 28 genera. 15% ($n = 723$) of all reptile trade records involved ball pythons, and 98% ($n = 710$) of those involved live snakes. Overall, 94% [$n = 4,564$] of all reptile trade records involved live animals. In total, ball python trade records, documenting exports from Togo between 1978 and 2017, represented the export of between 963,344 and 1,657,814 live individuals (according to exporter- and importer-reported quantities, respectively) – these figures comprised 53% of all live reptiles reported by Togo as exports during this period (Fig. 1; or 60% of all live reptiles reported as exports from Togo by importing countries). Other notable species (those involving a total of 100,000 or more individuals reported by Togo as exports over the same time period) were the Nile monitor lizard (*Varanus niloticus*), the savannah monitor lizard (*V. exanthematicus*), and the Senegal chameleon (*Chamaeleo senegalensis*).

According to both exporter- and importer-reported quantities, live ball python exports from Togo increased from $< 14,000$ per year in the late 1970s/early 1980s [following which there was a statistically significant increase of one to two thousand per year (1978 – 1987: exporter-reported trend = 1,974 per year, $F_{1,8} = 35.8$, $P < 0.001$, $R^2 = 0.82$; importer-reported trend = 1,490 per year, $F_{1,8} = 50.6$, $P < 0.001$, $R^2 = 0.86$)] to approximately 60,000 in 1991 (a four-fold increase over the 4 years between 1988 and 1991), reaching a peak of 74,751 (as reported by importing countries) in 1994 (Fig. 2A). Since the early 1990s, numbers reported by Togo (as exporter) suggest an overall increase (1992 – 2016: exporter-reported trend = 1,597 per year, $F_{1,23} = 11.20$, $P = 0.003$, $R^2 = 0.33$) but this was due to zero exports declared in 1997 and 2000, which importer-reported quantities suggest were incorrect (see Fig. 2A). Importer-reported quantities suggest that numbers of ball pythons exported from Togo since 1992 have actually remained relatively stable (at an annual average of 54,754), albeit with considerable fluctuation among years ($SD = 17,105$; importer-reported trend = 8.8,

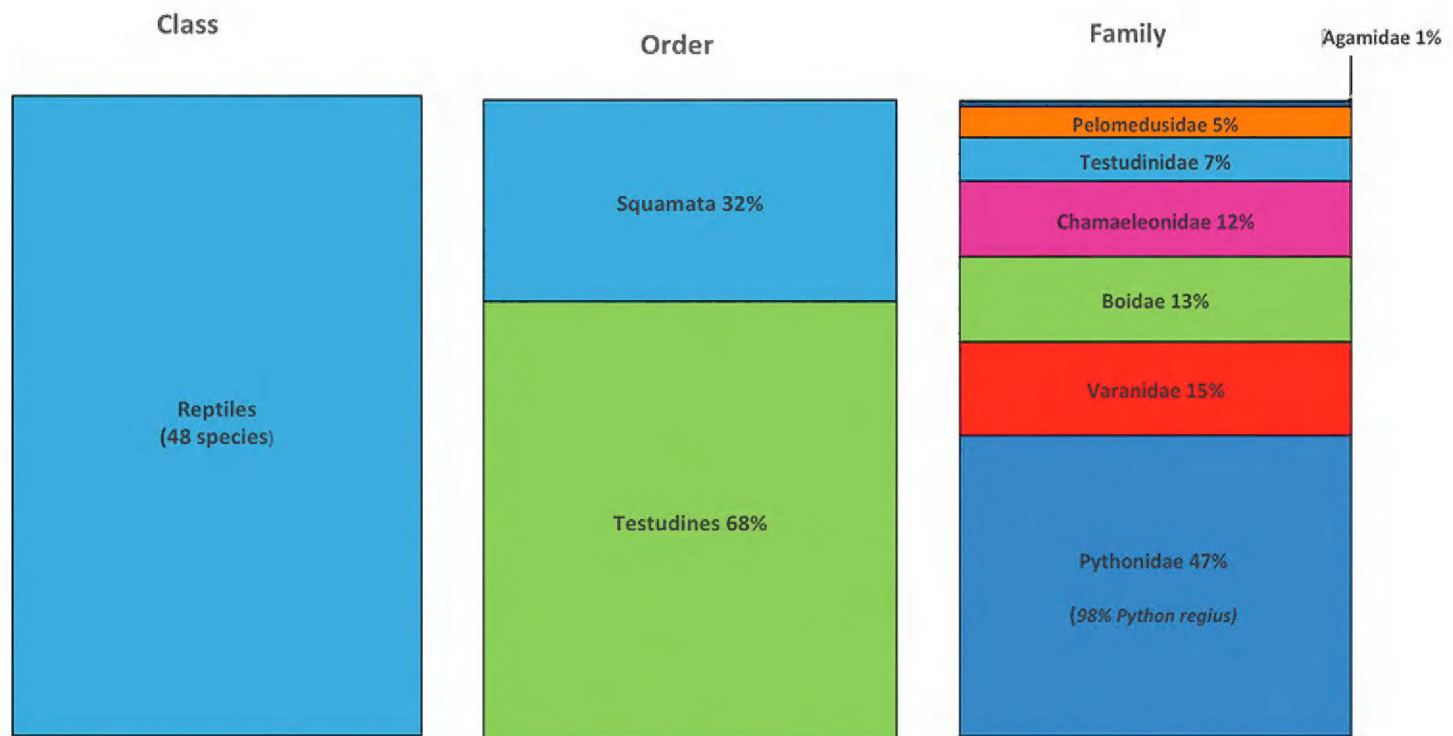


Figure 1. The proportion of all reptile species reported as live exports by Togo (1978–2017) in each taxonomic order and family. Source: CITES trade database, <https://trade.cites.org>

$F_{1,24} < 0.001$, $P = 0.985$, Fig. 2A). The highest annual export was of 88,959 individuals (reported by importing countries) in 2002 (the lowest reported by importing countries, since 1992, was 21,136 in 1995).

Discrepancies between annual exporter- and importer-reported quantities (Fig. 2B) suggest that, although exporter- and importer-reported annual totals were correlated ($r = 0.54$, $P < 0.001$), exports were consistently (in 31 of 39 years), and significantly, underestimated by Togo (paired t-test: $t = 4.44$, $df = 38$, $P < 0.001$). The maximum discrepancy (underestimate) recorded was 72,747. There were 8 years in which Togo over-estimated numbers exported (as compared to importer-reported quantities), notably, including the most recent four years of the study – in this case, the maximum discrepancy (overestimate) was 31,621. The mean absolute difference between annual exporter- and importer-reported quantities was 20,389.

In total, and according to both exporter- and importer-reported quantities, 99% ($n = 950,829$ and $1,647,639$ respectively) of individual live ball pythons exported from Togo were intended for commercial use (presumably as exotic pets). Since the years 1999/2000 wild-sourced snakes exported from Togo were largely replaced with ranched snakes (Fig. 3). Over the most recent 10–15 years of trade records analysed, at least 95% of total importer-reported exports (83% of exporter-reported exports) were ranched, and although high numbers (ca. 40,000) of wild-sourced animals were reportedly exported in 2001 and 2002 (by importers), wild-sourced animals since 2003 comprised $< 5\%$ of total exports reported by importing countries [Fig. 3; although slightly higher figures ($< 6\%$ and up to 17 and 20% on two occasions) were reported by Togo]. The change in proportion of animals ranched versus of wild origin over time (time period combined as three decades – 1990s, 2000s, and 2010s) was statistically significant (animal source - time association: $\chi^2 = 663760$, $df = 2$, $P < 0.001$).

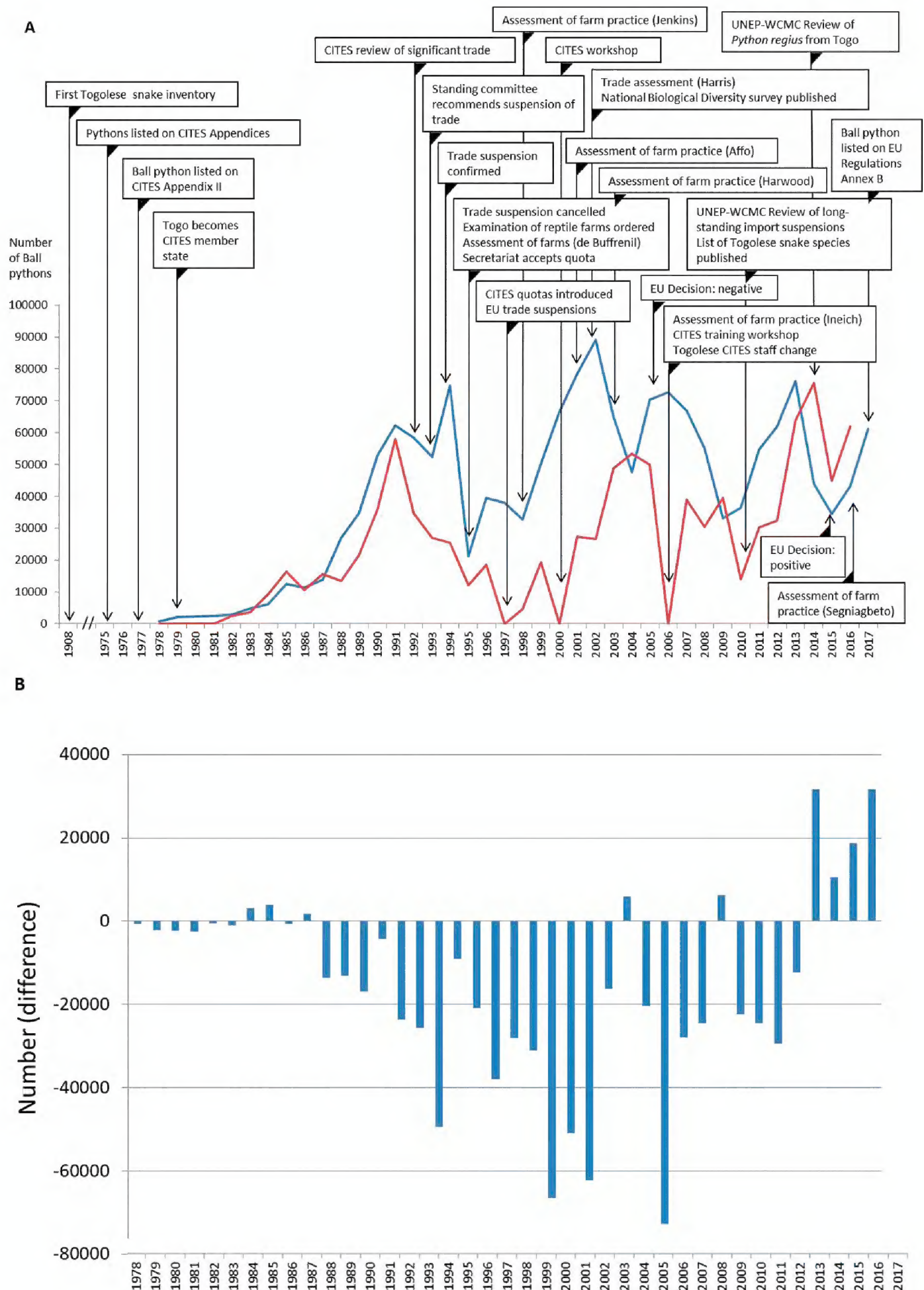


Figure 2. A Number of individual live ball pythons exported from Togo as reported by CITES, 1978–2017, showing exporter- (red) and importer-reported (blue) quantities against timeline of events associated with the regulation of ball python trade. Note that exporter-reported quantities were not available for 2017 at the time of analysis. **B** Annual discrepancies between exporter- (Togo) and importer-reported quantities. Source: CITES trade database, <https://trade.cites.org>

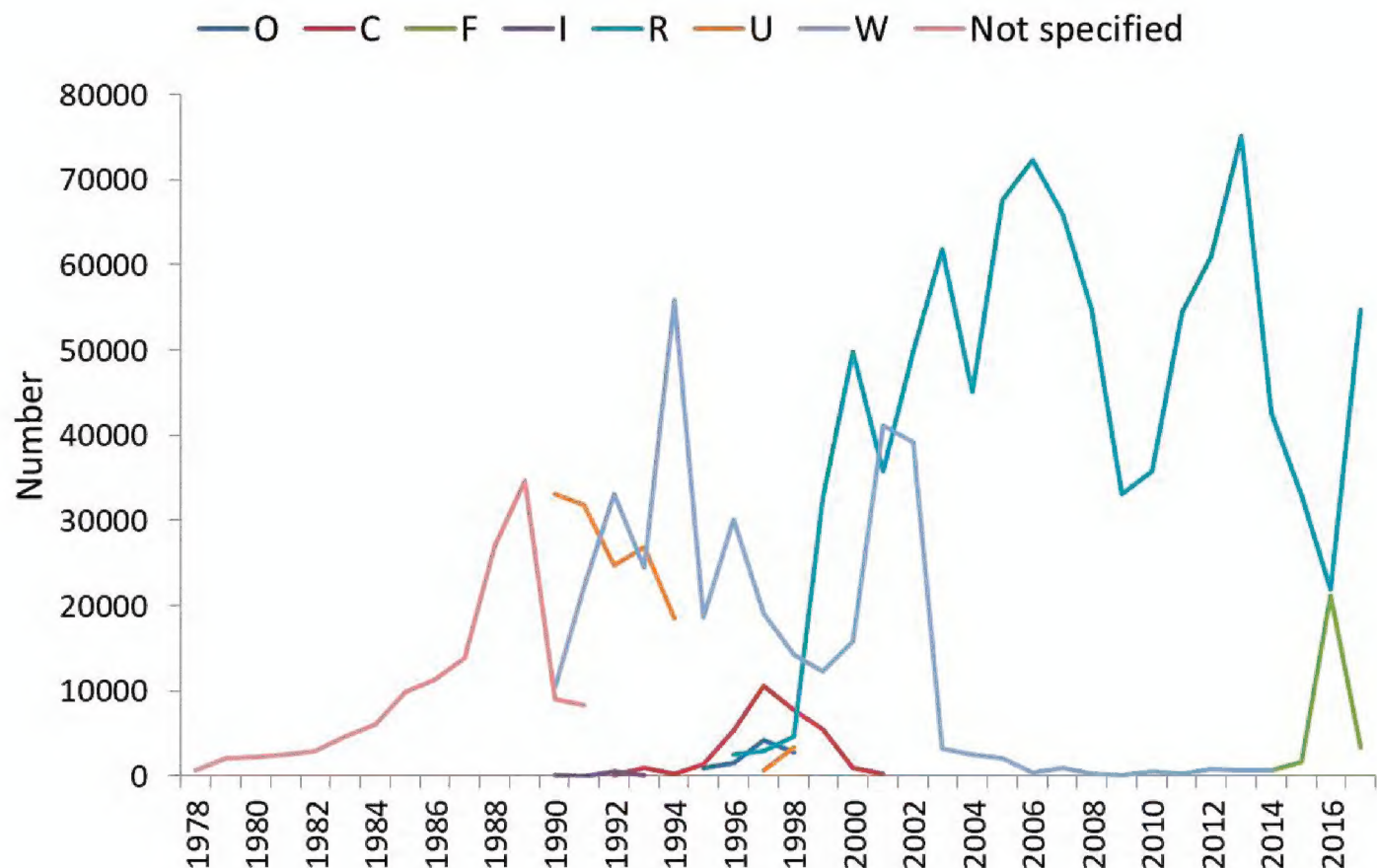


Figure 3. Reported source of ball pythons exported from Togo, based on importer-reported quantities obtained from CITES trade records. Note that the CITES trade database does not contain source information for most records prior to 1991 (unless the specimen was specifically declared as captive-bred, CITES 2013). O=pre-convention specimens, C=captive-bred, F=born in captivity, I=confiscated or seized, R=ranch, U=unknown, W=wild. Source: CITES trade database, <https://trade.cites.org>

CITES trade records reported exports of ball pythons from Togo to 58 different countries between 1978 and 2017, in total quantities for the period that varied between 1 and over 1 million ball pythons per country; note, however, that minima and maxima represent extreme cases, and that, for most (71.4%) countries, reported exports ranged between 100 and 9,000 ball pythons. Both exporter- and importer-reported quantities showed the USA to be the largest importer, responsible for between 60 and 77% of exports (for exporter- and importer-reported quantities respectively). Six other countries reported importing >1% of the total over this period: France (7.5%), Germany (4.3%), Italy (2.7%), Spain (1.3%), Belgium (1.2%), and Japan (1.1%). Exporter-reported quantities suggested that three additional countries – the Netherlands, Hong Kong and Ghana – also imported >1% of the total (1.6, 1.3 and 1.7, respectively). At a regional level, Europe was second to North America (USA and Canada; there were no exports reported to Mexico) as importer of Togolese ball pythons, responsible for between 30 and 20% of exports (for exporter- and importer-reported quantities respectively) (Fig. 4A, B).

Since the 1990s (following an increase in ball python exports from Togo in the latter half of the 1980s; see Fig. 2), North American imports of ball pythons from Togo have fluctuated considerably through the years. The highest annual imports into North America were of 72,000 ball pythons in both 1994 and 2002 – annual imports since 2002 were at least 13,000 lower than these figures suggesting some level of a decline in

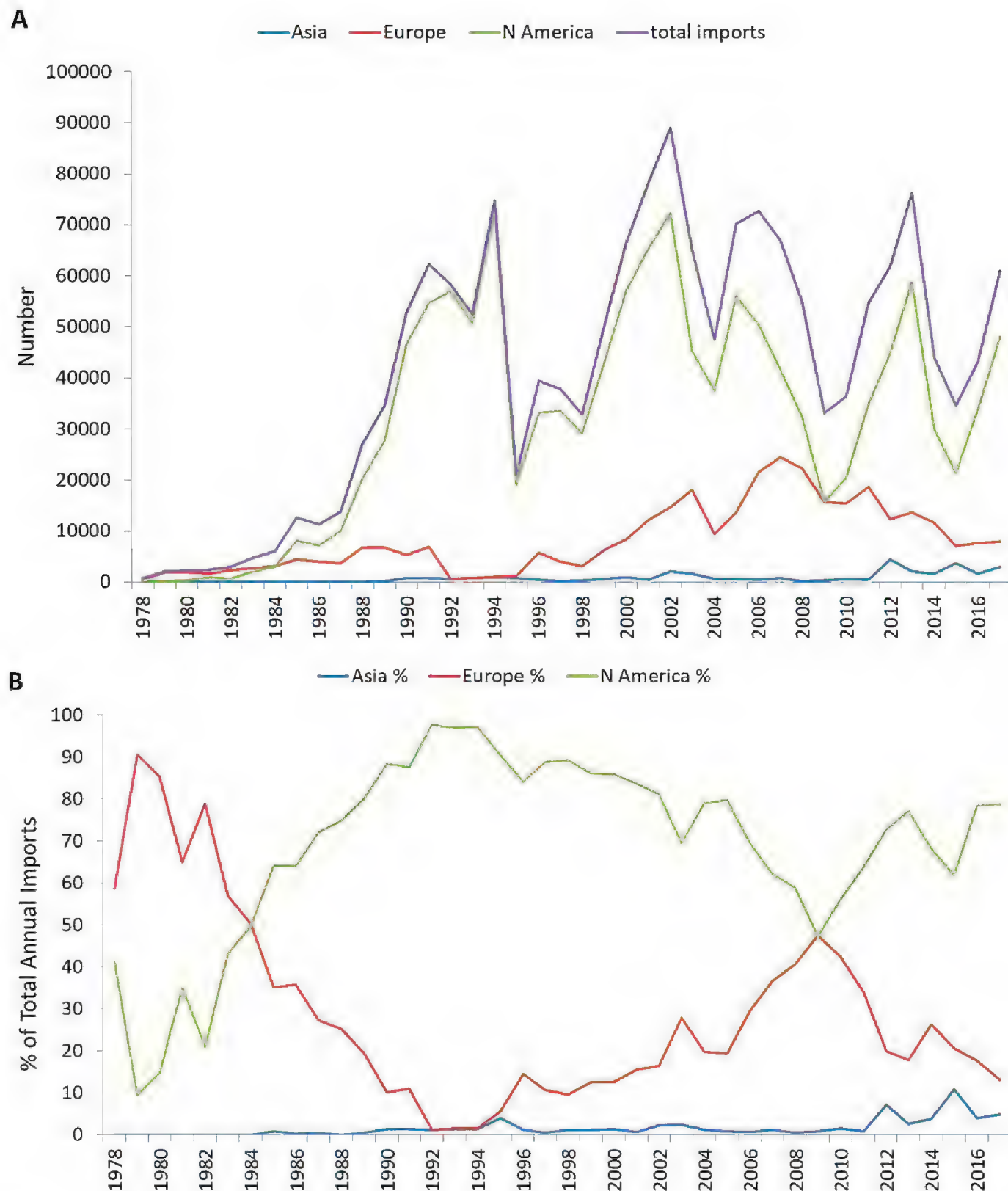


Figure 4. The annual number (**A**) and proportion (**B**) of ball pythons from Togo imported by three main world regions (Asia, Europe and North America), 1978–2017. Proportion shown as % total ball python imports from Togo. Data derived from Togo export records on CITES trade database, and based on importer-reported quantities. Source: CITES trade database, <https://trade.cites.org>

North American imports (cf. Luiselli et al. 2012), but longer-term trends (1992–2017) were not statistically significant (annual average imports into North America, 1992 – 2017 = 42,507, SD = 15,911, trend = -611, $F_{1,24} = 2.26$, $P = 0.146$, Fig. 4A). More recently, over the last ten years, a decrease in the numbers imported by Europe (from 22,377 in 2008 to 8,026 in 2017, trend = -1499 per year, $F_{1,8} = 39.04$, $P < 0.001$), which was not mirrored by numbers imported into North America (trend = 1645 per year, $F_{1,8} = 1.27$, $P = 0.292$; i.e. there was no evidence that the apparent decline in

North American imports had continued, Fig. 4A) means that the proportion of ball python exports from Togo being imported into North America has increased (from 59% of total imports in 2008 to 79% of total imports in 2017; Fig. 4B). Numbers imported into Asia have also increased over the last ten years (from 226 in 2008 to 2,980 in 2017, trend = 313 per year, $F_{1,8} = 5.44$, $P = 0.048$) but the low numbers involved mean that in 2017 (the most recent year in the dataset) Asia was responsible for < 5% of all imports (Fig. 4B).

In the 21 years between 1997 and 2017, importer-reported quantities suggest that ranched ball python annual quotas have been exceeded on six different occasions (by an average of 10,421, maximum 19,787), most recently in 2013 (by 12,626 ball pythons, Fig. 5A). However, according to export records provided by Togo, the ranched ball python quota has only been exceeded on three occasions (once, in 2014, by a total of 10,712 ball pythons, and twice more, in 2004 and 2013, by 174 and 23, respectively, Fig. 5A). With regards to ball pythons reported as wild sourced, according to importing countries the CITES quota has been exceeded on ten different occasions (by an average of 13,730; maximum 39,644 in 2001) most recently in 2017 (by 1,450 ball pythons, Fig. 5B), whilst exporter-reported quantities suggest that the quota was exceeded on six occasions (by between 250 and 4,000), most recently in 2014 (by 290 ball pythons, Fig. 5B).

The LEMIS trade database documents the import of a total of 764,527 live ball pythons from Togo into the USA since the year 2000. Ball pythons came from 11 independent Togolese exporters, two of which (Togamin and Pajar Sarl) were responsible for 88% of all ball pythons imported over this period (55%; $n = 422,867$ and 33%; $n = 251,969$, respectively, Fig. 6), five others were responsible for 1–5% imports (Fig. 6). Annual imports documented by LEMIS did not differ significantly from importer-reported quantities in the CITES trade database ($t = -0.01$, $df = 17$, $P = 0.988$, mean = 42,474 vs. 42,495, respectively; Fig. 6).

Current trade: species observed at reptile farms

In total, (including only those identified to species level, plus those of ambiguous taxonomic status indicated by “cf.”) 46 reptile species were observed during visits to the eight different farms in Togo (including seven python farms and one venom farm) between February 2018 and April 2019, including 1 Crocodylia (2%), 10 Sauria (21%), 24 Serpentes (52%), and 11 Testudines (24%) (please see Appendix I). Observed species diversity at the farms ranged between three and 23.

With regards to conservation and population status of the 46 species observed, over half (59%, $n = 27$) had not yet been evaluated on the IUCN Red List. Of the 19 observed species that were included on the IUCN Red List most (68%, $n = 13$) were categorised as Least Concern but for most of these ($n = 12$, 63% of all Red List species) conservation status was unknown (please see Appendix I, and Appendix II). Four species observed on farms [the African spurred tortoise (*Centrochelys sulcata*), Senegal flap-shell turtle (*Cyclanorbis senegalensis*), Home’s hinge-back tortoise (*Kinixys homeana*),

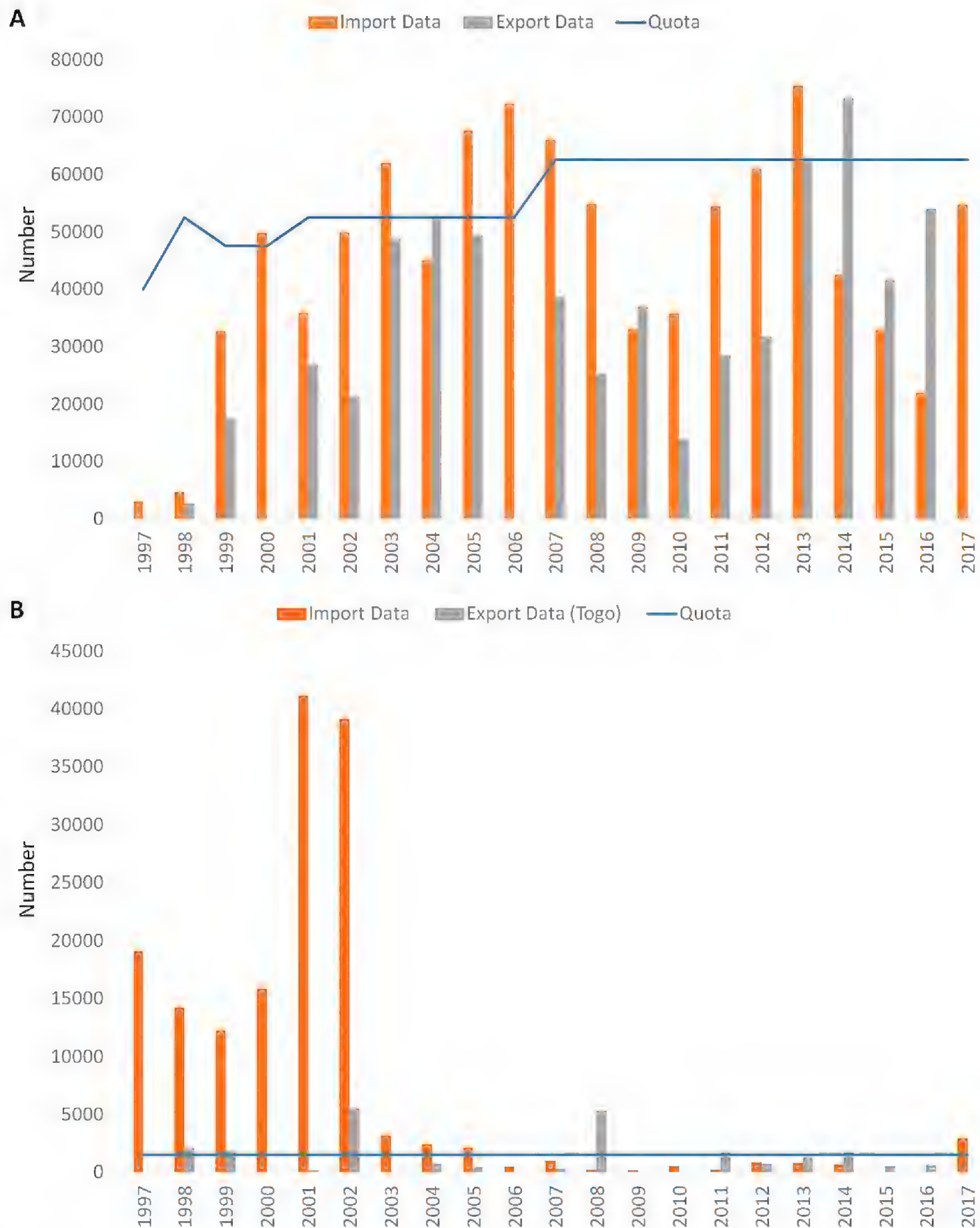


Figure 5. The number of ranched (**A**) and wild (**B**) specimens of ball pythons exported annually since 1997, according to export data (from Togo) and import data (from all importing countries) recorded on CITES trade database, in comparison with the annual quota set for ball python exports from Togo. Source: CITES trade database, <https://trade.cites.org>

and African softshell turtle (*Trionyx triunguis*)] were categorised on the IUCN Red List as Vulnerable, and two [the West African black turtle (*Pelusios niger*) and Geyr's spiny-tailed lizard (*Uromastix geyri*)] as Near Threatened - wild populations of all but one of these species were reported to be decreasing. There was no evidence that the propor-

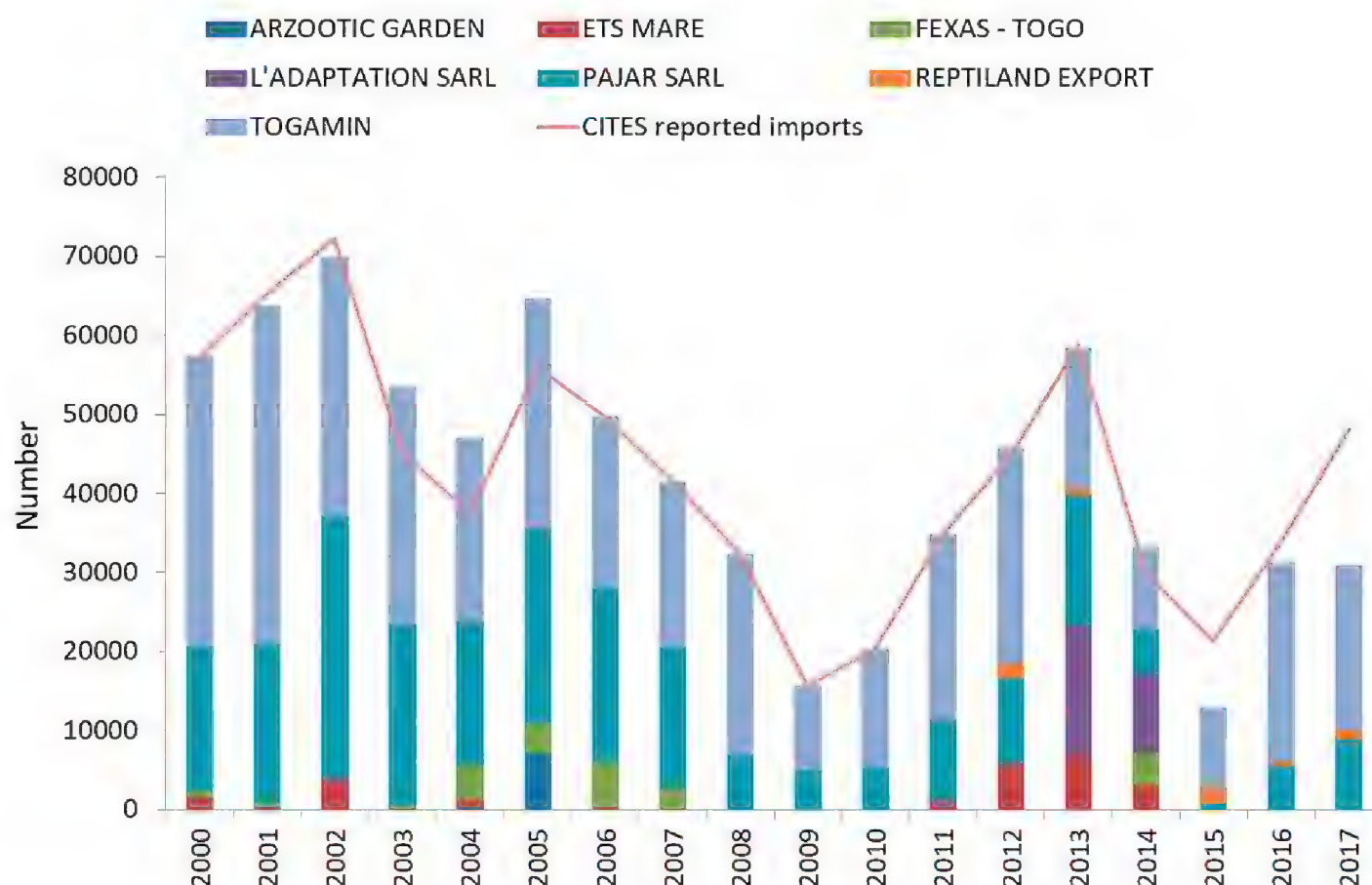


Figure 6. The number of ball pythons exported by the different reptile farms in Togo into the USA annually since 2000, as recorded on LEMIS trade database, shown against CITES-reported USA imports (Source: CITES trade database, <https://trade.cites.org>).

tion of threatened or declining species observed at farms differed from expectations as compared to all Togolese reptiles listed on the IUCN Red List (conservation status: $\chi^2 = 3.52$, $df = 5$, $P = 0.707$; population status: $\chi^2 = 0.427$, $df = 2$, $P = 0.808$).

With regards to the geographic distribution of these 46 species, a total of 10 species (22%) are considered as regionally endemic to West Africa, and 32 species (70%) are considered as widespread (extending to regions outside western Africa) according to information provided by the IUCN Red List (IUCN 2019), (please see Appendix I, and Appendix II). A total of 36 (78%) of these species (including three taxa in species complexes) are native to Togo. A total of nine species are considered endemic to other countries and / or regions in Africa than Togo [i.e. *Centrochelys sulcata*, Bell's hinge-back tortoise (*Kinixys belliana*), leopard tortoise (*Stigmochelys pardalis*), Peter's banded skink (*Scincopus fasciatus*), *Uromastix geyri*, Gaboon viper (*Bitis gabonica*), green mamba (*Dendroaspis angusticeps*; this species is confined to central-eastern and southern Africa), black mamba (*D. polylepis*; a published distribution record of this species for Togo is pending) and the Northeast African carpet viper (*Echis pyramidum*) that is a regional endemic outside of West Africa]. A total of five taxa (11%) have unknown distributions as they were not identified to species level and 26 species (57%) are definitely or likely also supplied by another country or range state, and exported by Togo (please see Appendix I, and Appendix II). A total of 19 observed species (41%) are listed on CITES Appendix II, except the West African crocodile (*Crocodylus suchus*)

that is listed on CITES Appendix I [Note: the West African populations of the Nile crocodile are still listed as *Crocodylus niloticus*, UNEP 2019].

Discussion

Togo remains a substantial source of live reptiles, both native and non-native, with at least 19 CITES-listed species currently held at reptile farms. In terms of the number of animals traded, the most notable species exported by Togo since 1978 under CITES is the ball python; with 1,657,814 live individuals - comprising 60% of all live reptiles – reported by importing countries. In total, 99% of the ball pythons legally exported from Togo under CITES have been intended for commercial use as exotic pets. Since the turn of the century, wild-sourced snakes exported from Togo have been largely replaced with specimens declared as “ranchered (R)”, to the extent that in the last 10 years 95% of all live exports were recorded using CITES source code “R”. Ball pythons have been exported from Togo to 58 different countries since 1978. With regards to the global trade trend, CITES importer-reported quantities suggest that numbers of ball pythons exported from Togo since 1992 until 2019 (following a rapid increase in reported trade levels in the late 1980s/early 1990s) have overall remained relatively stable (at an annual average of 54,754 live animals), albeit with considerable fluctuation among years (Fig. 3). Importer-reported quantities by CITES showed the USA to be the largest importing country, responsible for 77% of exports since 1978 (also see Luiselli et al. 2012). At a regional level, over the last ten years, a decrease in the numbers imported by Europe, which was not mirrored by numbers imported into North America (USA and Canada), has meant that the proportion of ball python exports from Togo being imported into North America has effectively increased during this period.

Ball python ranching: boom or bust?

The provision of captive breeding and ranching operations as a replacement for the potentially unsustainable sourcing of wildlife from their natural habitats, as observed for ball python CITES exports reported from Togo, is not new (e.g., Rosen and Smith 2010; Harfoot et al. 2018). Indeed, such initiatives have been in operation for several decades, and in certain circumstances (e.g., crocodilians) deemed a successful conservation tactic overall (Nogueira and Nogueira-Filho 2011), albeit not one without associated animal welfare challenges (Dutton et al. 2013). However, in recent years researchers have also drawn attention to the fact that the actual numbers of species that receive overall net conservation benefits from this type of production system may be relatively few and far between (Tensen 2016). Specifically, in many cases data are lacking as to whether farm produced “products” represent a true substitute for wild sourced counterparts (e.g., bear bile; Dutton et al. 2011), whether farmed wild animals are cost

efficient enough to combat poaching and black market prices (e.g., sea turtle meat; D'Cruze et al. 2015), and whether they are being effectively managed well enough to demonstrably disallow laundering [e.g., Tokay geckos (*Gekko gecko*); Nijman and Shepherd 2015; green tree pythons (*Morelia viridis*); Lyons and Natusch 2011].

In the context of ball pythons, recent scientific studies have raised conservation concerns regarding current production methods being implemented in West Africa to supply the international exotic pet trade. In Benin, Toudonou (2015) described a link between the legal hunting / ranching of ball pythons and the illegal trade of ball pythons as bush meat. Toudonou (2015) also stated “farmers and ball python collectors unanimously reported that this species is under severe threat in Benin” via reduced ball python hunting success rates, increased hunting localities, hunting effort and associated costs compared to 20 years previous. Similarly, recent research in Togo has identified a link between the legal hunting / ranching of ball pythons and the illegal trade of ball pythons as traditional medicine (D'Cruze et al. 2020b) and has also revealed that local hunters report a reduction in the availability of wild ball pythons between 2014 and 2018 (D'Cruze et al. 2020a). Furthermore, a recent genetic analysis of wild ball pythons has indicated that the largely unregulated wild release component of the python production process in Togo is resulting in “genetic pollution” that may be having a long-term negative impact on the conservation of wild populations (Auliya et al. 2020) and welfare of individual snakes (D'Cruze et al. 2020a). Our study now also draws attention to the fact that the number of ball pythons exported by Togo is likely to be consistently higher than officially reported to CITES by Togo (predominantly for ranched individuals, although some improvement has been seen in the last three to four years in terms of under-reporting) and that ball python quotas (ranched and wild-sourced) are still frequently exceeded. Indeed, in 2017, exporter-reporter quantities suggest that the wild-source quota was exceeded by over 1,000 individuals.

Conservation and animal welfare implications

The ball python has a relatively large distribution, fast reproductive rate, and occurs in a wide range of habitats including some areas with formal protected status and some areas inhabited by local communities who consider the species to be sacred (Toudonou 2015). Consequently, with regards to its conservation status, this species is currently classified as “Least Concern” with a population trend considered as “Unknown” according to the IUCN Red List of Threatened Species (Auliya and Schmitz 2010). However, this last conservation assessment was made almost ten years ago and is in need of updating. Given the conservation concerns (listed above) associated with current production systems there are questions regarding whether a higher conservation status may be more appropriate (Toudonou 2015), especially given that this species is also traded legally in relatively large volumes that specifically target the most vulnerable life stages (i.e., gravid females) (Toudonou 2015; D'Cruze et al. 2020a), it currently faces a variety of other threats to its survival in the wild [e.g., expanding agricultural

mechanisation, pesticide use (Toudonou, 2015) and local subsistence use (Auliya and Schmitz 2010)], and detailed studies on population status and distribution are currently lacking (Auliya and Schmitz 2010). In addition, the causes of regional declines in several snake species distributed across the world still remain unknown (Reading et al. 2010).

Animal welfare impacts are associated with every step of a wildlife trade chain including capture, restraint, transport and subsequent captivity irrespective of a species' legal status, but they rarely feature in the relevant published scientific literature (Baker et al. 2013). In the context of ball python production systems in West Africa, D'Cruze et al. (2020a) have already drawn attention to the animal welfare concerns associated with removal of ball pythons from their burrows, transport and sub-standard care provided at "holding facilities" prior to their arrival at python farms. However, observations made during our visits to python farms also raise additional animal welfare concerns that have not been referred to by previous assessments of these types of facility in Togo (e.g., de Buffrénil 1995; Jenkins 1998; Ineich 2006). In particular, cases of high stocking density (including overt and crypto-over-crowding, Warwick et al. 2013), a lack of space and shelter, poor food, water, hygiene and substrate availability were some of the issues observed at the facilities visited during our fieldwork (Fig. 7). Detailed physical examinations and behavioural observations were not made during this study and data on duration, morbidity and mortality rates were not gathered. However, physical injuries and stress associated with sub-optimal captive conditions at python farms are likely resulting in some deaths and disease.

Other reptile species

Our study provides the most complete account of species diversity present at snake breeding farms in Togo that has been published to date. Many of these species, like ball pythons, are not currently considered threatened according to the IUCN Red List assessment, but although there was no evidence that farms were specifically selecting threatened species, they were not avoiding them either. And, for species that have been categorised as non-threatened, trade is being carried out in a manner that means that a non-threatened status is not necessarily still the case or will be in future. This is reflected by the fact that a number of species observed during our visits to ball python breeding farms are already currently involved in the CITES Review of Significant Trade, a procedure [defined in Res. Conf. 12.8 (Rev. CoP18)] designed to identify species that may be subject to unsustainable levels of international trade, and to identify problems and solutions concerning effective implementation of the Convention (CITES 2019). Specifically, the graceful chameleon (*Chamaeleo gracilis*) and *Kinixys homeana* from Togo have been included in this process since 2010, as have the ornate Nile monitor (*Varanus ornatus*) since 2013, and *Uromastix geyri* since 2017, respectively due to international concerns relating to sourcing, high volumes and sharp increases in trade (AC30 Doc. 12.2; <https://cites.org/sites/default/files/eng/com/ac/30/E-AC30-12-02.pdf>).



Figure 7. Images of species encountered during visits to the eight snake farms: **A** juvenile *Python regius* **B** example housing conditions **C** juvenile *Varanus ornatus*; and **D** juvenile *Varanus exanthematicus*. Images show typical barren enclosures with overt overcrowding, no shelter and species exhibiting interactions with transparent boundaries. Photos: **A, B** (Neil D'Cruze) **C, D** (M. Auliya).

Similarly, a number of species observed during our visits to ball python farms are already currently involved in the CITES Review of Trade in Animal Specimens Reported as Produced in Captivity, a procedure (defined in Resolution Conf. 17.7 and Decision 17.105) designed to help prevent the inadvertent misuse of CITES source codes, and deliberate fraudulent claims that wild-caught specimens were captive bred. Specifically, *Varanus exanthematicus* and *Centrochelys sulcata* from Togo have been included in this process due to recent high volumes of trade, shifts, and international concerns that these species are not being “ranching” in conformity with CITES requirements [as stated in Res. Conf.11.16 (Rev. CoP15)]. In the case of *C. sulcata* there are also specific concerns regarding the questionable use of

source code “F” (born in captivity) and “R” (ranch) given that this species is not native to Togo.

Our field visits now draw attention to a longer list of species for potential consideration in future CITES review procedures. Togo has a well-established infrastructure for intercontinental shipments and has been identified as one of the major hubs for the export of live African reptiles (Jensen et al. 2018), thus species not native to Togo (please see Appendix I) are additionally very likely all sourced from range States, and in both cases shipped abroad via Togo’s capital, Lomé. In particular, the trade of species that are also not native to Togo and not listed on the CITES Appendices, i.e. *Echis pyramidum* and *Scincopus fasciatus*, those already considered as Threatened, native to Togo and listed on CITES i.e. *Cyclanorbis senegalensis* and *Trionyx triunguis*, are arguably of most immediate interest in this regard. Those that have triggered a constant international demand e.g., mud turtles (Pelomedusidae spp.), hinge back tortoises (*Kinxys* spp.; CITES Appendix II), the Fat-tail gecko (*Hemitheconyx caudicinctus*), rough-scaled plated lizard (*Broadleysaurus* [*Gerrhosaurus*] *major*), fire skink (*Mochlus* [*Lepidophyrus*] *fernandi*, Mueller’s sand boa (*Eryx muelleri*; CITES Appendix II) also likely warrant increased attention from an international trade policy perspective.

Limitations

CITES trade records are known to be incomplete and error-prone (e.g., Phelps et al. 2010) and by definition only reflect legal trade. We have not attempted here to quantify any illegal export of ball pythons out of Togo. However, as regards legal trade, whilst most studies based on CITES trade records tend to use either importer- or exporter-reported quantities we analysed both quantities separately, which provided a more detailed and nuanced insight into trade patterns and trends. The two quantities may differ for a number of reasons including, for example, the use of different codes by exporter and importer and/or exports being recorded as imports the year after they were exported (CITES 2013). There is, therefore, a significant risk that restricting analyses to one quantity under- or over-estimates trade and to misses pertinent details (such as an undeclared destination country) – the limitation associated with comparative analyses of both quantities is that it is not possible from the CITES trade database to verify which is more accurate.

Our time at the eight snake facilities in Togo was limited and intermittent. It is therefore very likely that species lists compiled are incomplete and thus should be treated as an initial conservative list only. The assumption, that these species lists are incomplete, is also supported by species groups such as the Egyptian cobra (*Naja haje*) (Trape et al. 2009) and the forest cobra (*Naja melanoleuca*) (Wüster et al. 2018) that have recently been shown to include additional new species. There are also taxonomic uncertainties brought about by superficial “look-alike” species and or those that may have been introduced through trade activities (e.g., Pelomedusidae spp.) (Vargas-

Ramírez et al. 2010; Wong et al. 2010). However, as these are the species that were presented by owners when asked and aware of our visit in advance – it likely shows a good representation and is ultimately the only existing data available. Ideally, we would have compared the species observed on farms with those that occur in western Africa (particularly with respect to their conservation and their national legislative status) in order to better understand which species are selected by python breeding farms. But this analysis was limited because the majority of Togolese, and indeed West African reptiles, has not yet been assessed for inclusion on the IUCN Red List. Should a national red list assessment be initiated for Togo, we would recommend that the following species should be made a priority given the commercial trade activity observed during this study: chameleons (*Chamaeleo* spp.), monitor lizards (*Varanus* spp.), Calabar ground boa (*Calabaria reinhardtii*), *Eryx muelleri*, Northern African rock python (*Python sebae*), *Kinxys* spp. and non-CITES listed species, e.g., *Mochlus fernandi*, *Hemitheconyx caudicinctus*, *Broadleysaurus major*, Jameson's green mamba (*Dendroaspis jamesoni*), bush vipers (*Atheris* spp.), rhinoceros viper (*Bitis nasicornis*) and the West African gaboon viper (*B. rhinoceros*) (cf. Segniagbeto et al. 2011, 2015).

Recommendations

In light of recent concerns regarding the hunting and release practices that underpin python farms in West Africa (Toudonou, 2015; Auliya et al. 2020; D'Cruze et al. 2020a,b), and concerns regarding the sustainability and compliance of trade in other reptile species produced via these farms (AC30 Doc. 12.2; AC30 Doc. 13.1), it is recommended that ball pythons, and other reptile species, exported using source code “R” (ranch) and “W” (wild) in Togo (but also Benin and Ghana) should be reconsidered for inclusion in future CITES procedures (within the CITES e.g., Reviews of Significant Trade procedures or Trade in Animal Specimens Reported as Produced in Captivity; see <https://cites.org/eng/imp/sigtradereview>, <https://cites.org/sites/default/files/document/E-Res-17-07.pdf>). However, given that such a process can be lengthy and time consuming, in the short term we recommend that the Togo export quotas for ball pythons (currently set at 62,500 ranch snakes) be urgently revised (cf. Auliya et al. 2020; D'Cruze et al. 2020a). In addition, given that recent conservation assessments (and biological field data required to underpin them) are currently lacking for reptile species in Togo, it is recommended that Togo should consider composing a National Red List for its reptiles. Such information would be vital to help inform and define any future common legal tools in a tripartite agreement between the three main ball python range states in West Africa that are predominantly involved in their commercial export (Benin, Ghana and Togo). Furthermore, we recommend studies focused on morbidity and mortality rates of species during collection and transport from the point of harvest (within Togo and other range States) to the exporter's premises, prior to export. This information is lacking and vital to understand and potentially revise current trade practices in this regard.

Conclusions

The aim of this paper was to provide information specific to the ball python trade in Togo to inform current management practice. Additional information is needed – notably, on the understanding, attitudes and behaviour of consumers, as well as on the population dynamics and status of ball pythons. More broadly, this system is of interest to those concerned with sustainable use, substitutability, and the links between the various forms of “captive” and wild populations, and as such has parallels with a number of other traded wildlife species including ranched crocodilians (Jenkins et al. 2004), and captive bred lions (Coals et al. 2019). We envisage that the wider relevance of this large-scale reptile ranching system will be addressed fully elsewhere.

Legal and sustainably managed commercial wildlife trade has been proposed as a vital conservation tool, that in some cases is necessary to ensure the long-term survival of wild populations (Dutton et al. 2013). Conversely, when not properly managed, and / or required baseline information is lacking, wildlife trade (both legal and illegal) can impede conservation efforts (Bush et al. 2014). The severe threat of direct exploitation of organisms, such as harvesting animals for trade, was clearly indicated by Maxwell et al. (2016), and was calculated as the 2nd largest driver of change to nature in the UN global assessment report on biodiversity and ecosystem services, closely following changes in land and sea use (IPBES 2019).

The ball python is the most commercially traded live wild animal under CITES from Africa over the past five years which have ostensibly involved ranching operations (Auliya et al. 2020; D’Cruze et al. 2020a). The shift away from wild-sourced ball pythons in West Africa was once considered to provide a degree of protection for the ball python; however, in light of recent research, there is growing concern that the trade in this species is improperly managed and may not confer any significant net conservation benefits. In conclusion, we note that Togo’s ranching operation per se is inappropriately managed and lacks overall monitoring (cf. Auliya et al. 2020; D’Cruze et al. 2020a), that impedes a legal, sustainable and traceable trade of the ball python. We recommend further scrutiny and research is required in this regard to ensure the long-term survival of wild ball python populations.

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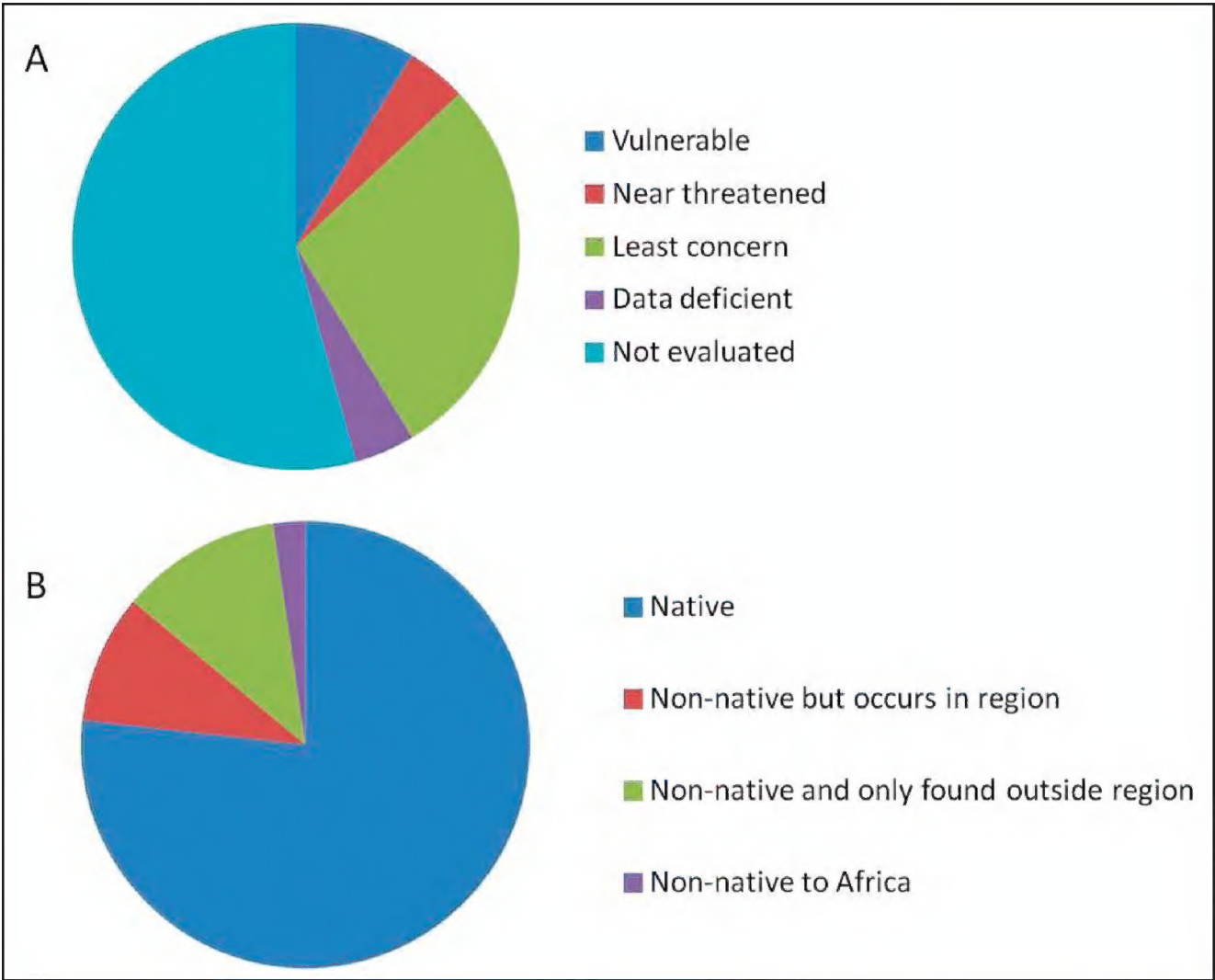
Appendix I

Reptile species observed across seven reptile farms in Togo (2018–2019), with associated IUCN Red List and CITES Appendices classifications. “Distribution” refers to the geographical distribution of the species and allocated to: “RE” = Restricted to western Africa i.e. Benin, Burkina Faso, Cape Verde, The Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, the Niger, Nigeria, Senegal, Sierra Leone and Togo); “W” = widespread species also occurring in Africa outside of this region; when “RE” or either “W” are attached with a “1” means that the species is native to Togo; when “RE” is attached with a “2” implies that western African species extend beyond this region, and when “W” or either “RE” is attached with a “3” that the species is definitely, or likely also supplied by another country or range State; exotic species not distributed on the African continent were classified with “Other”; *): resurrected from *Crocodylus niloticus* (Schmitz et al. 2003); **): refer to species complexes (see text); NA = Not Applicable.

Family	Species	IUCN Conservation Status	Date Assessed (IUCN)	Population Status (IUCN)	CITES Status	Distribution Status
Crocodylidae	<i>Crocodylus suchus</i> *	NE		NA	I	RE ^{2,3}
Agamidae	<i>Agama agama</i>	NE		NE	NL	W ¹
Agamidae	<i>Agama</i> sp.	NA		NA	NA	NA
Agamidae	<i>Uromastyx geyri</i>	NT	July 2012	Decreasing	II	RE ³
Agamidae	<i>Uromastyx</i> sp.	NA		NA	NA	NA
Chamaeleonidae	<i>Chamaeleo senegalensis</i>	VU	July 2012	Unknown	II	RE ¹
Eublepharidae	<i>Hemitheconyx caudicinctus</i>	LC	July 2012	Unknown	NL	RE ^{2,3}
Gerrhosauridae	<i>Broadleysaurus major</i>	NE		NE	NL	W ^{1, 3}
Scincidae	<i>Mochlus fernandi</i>	NE		NE	NL	W ^{1,3}
Scincidae	<i>Scincopus fasciatus</i>	DD	June 2009	Unknown	NL	W ³
Varanidae	<i>Varanus exanthematicus</i>	LC	June 2009	Unknown	II	W ^{1,3}
Varanidae	<i>Varanus niloticus</i>	NE		NE	II	W ¹
Varanidae	<i>Varanus ornatus</i>	NE		NE	II	RE ^{2,3}
Boidae	<i>Calabaria reinhardtii</i>	NE		NE	II	W ^{1,3}
Boidae	<i>Eryx muelleri</i>	NE		NE	II	W ^{1,3}
Colubridae	<i>Dasypeltis</i> cf. <i>gansi</i>	NE		NE	NL	W ¹
Colubridae	<i>Dasypeltis</i> sp.	NA		NA	NA	NA
Colubridae	<i>Dasypeltis confusa</i>	NE		NE	NL	W ¹
Colubridae	<i>Dispholidus typus</i>	NE		NE	NL	W ¹
Colubridae	<i>Philothamnus</i> cf. <i>irregularis</i>	LC	June 2009	Unknown	NL	W ¹
Elapidae	<i>Dendroaspis angusticeps</i>	NE		NE	NL	W
Elapidae	<i>Dendroaspis jamesoni</i>	NE		NE	NL	W ^{1,3}
Elapidae	<i>Dendroaspis polylepis</i>	LC	June 2009	Stable	NL	W ³
Elapidae	<i>Dendroaspis viridis</i>	LC	July 2012	Stable	NL	W ^{1, 3}
Elapidae	<i>Naja melanoleuca</i> **	NE		NE	NL	W ¹
Elapidae	<i>Naja nigricollis</i>	NE		NE	NL	W ¹
Elapidae	<i>Naja</i> sp.	NA		NA	NA	NA
Lamprophiidae	<i>Mehelya poensis</i>	NE		NE	NL	W ¹
Psammophiidae	<i>Psammophis</i> cf. <i>sibilans</i>	NE		NE	NL	W ¹
Psammophiidae	<i>Rhamphiophis oxyrhynchus</i>	NE		NE	NL	W ¹
Pythonidae	<i>Morelia viridis</i>	LC	June 2017	Stable	II	other

Family	Species	IUCN Conservation Status	Date Assessed (IUCN)	Population Status (IUCN)	CITES Status	Distribution Status
Pythonidae	<i>Python regius</i>	LC	June 2009	Unknown	II	W ^{1,3}
Pythonidae	<i>Python sebae</i>	NE		NE	II	W ¹
Viperidae	<i>Atheris chloroechis</i>	LC	July 2012	Unknown	NL	RE ¹
Viperidae	<i>Bitis arietans</i>	NE		NE	NL	W ¹
Viperidae	<i>Bitis gabonica</i>	NE		NE	NL	W ³
Viperidae	<i>Bitis nasicornis</i>	NE		Unknown	NL	W ^{1,3}
Viperidae	<i>Echis ocellatus</i>	NE		NE	NL	W ¹
Viperidae	<i>Echis pyramidum</i>	LC	June 2009	Unknown	NL	RE ³
Viperidae	<i>Echis</i> sp.	NA		NA	NA	NA
Pelomedusidae	<i>Pelomedusa subrufa</i> **	NE		NE	NL	W ^{1,3}
Pelomedusidae	<i>Pelusios c. castaneus</i>	NE		NE	NL	RE ^{1,3}
Pelomedusidae	<i>Pelusios niger</i>	NT	May 2018	Decreasing	NL	RE ^{1,3}
Testudinidae	<i>Centrochelys sulcata</i>	VU	Aug 96	Unspecified	II	W ³
Testudinidae	<i>Kinixys belliana</i>	NE	Aug 96	NE	II	W ³
Testudinidae	<i>Kinixys erosa</i>	DD	Aug 96	Unspecified	II	W ^{1,3}
Testudinidae	<i>Kinixys homeana</i>	VU	January 2006	Decreasing	II	RE ^{1,3}
Testudinidae	<i>Kinixys nogueyi</i>	NE		NE	II	RE ^{1,3}
Testudinidae	<i>Stigmochelys pardalis</i>	LC	Aug 14	Unknown	II	W ³
Trionychidae	<i>Cyclanorbis senegalensis</i>	VU	May 2016	Decreasing	II	W ¹
Trionychidae	<i>Trionyx triunguis</i>	VU	June 2016	Decreasing	II	W ¹

Appendix II



Conservation (**A**) and distribution (**B**) status of reptile species ($n = 46$ and $n = 43$, respectively) observed on Togolese farms. Conservation status as categorised by the IUCN Red List (IUCN 2019). Distribution status omitted for three taxa included in species complexes, thus taxonomic status here is considered uncertain.